

Public Report - Final
Approved by the plant
Energy Savings Assessment (ESA) Summary Report
Process Heating

For **Alcoa – Massena West Plant**
(ESA – 239-3)
December 2 – 4, 2008

Prepared By
Arvind Thekdi, E3M Inc.

Company	Alcoa Inc.	ESA Dates	December 2-4, 2008
Plant	Massena, NY (West plant)	ESA Type	Process Heating
Product	Aluminum products	ESA Specialist	Arvind Thekdi (E3M, Inc.)

Brief Narrative Summary Report for the Energy Savings Assessment:

Introduction: An Energy Savings Assessment (ESA) was carried out at Alcoa – Massena West plant, at Massena, NY. The plant produces primary aluminum metal shapes that are used for production of various aluminum parts. This plant uses primary molten aluminum, scrap chips and other aluminum scrap as its incoming feed stock. The equipment used in the plant includes several melting and holding furnaces, homogenizing furnaces and thermal incinerators associated with the chip melting furnaces. In addition to this the plant uses boilers to generate steam that is used for space heating during the colder weather months. All heating equipment and boilers use natural gas to supply necessary energy.

The assessment was initiated by Mike Caufield Energy Regulatory Specialist, Alcoa Inc. Knoxville and supported by Stacy Dutch and Bill Welsch of Massena – West plant. The assessment activities were attended by Eider Simielli of Alcoa Technical Center and Francis Caron of Alcoa Montreal (Canada). The assessment was led by the DOE process heating specialist Arvind Thekdi. Prior to the assessment Arvind Thekdi of E3M, Inc. discussed details of the assessment with Mike Caufield reviewed available data on energy use in the plant heating equipment. We also helped the attendees to download Process Heating Assessment and Survey Tool (PHAST) program on a computer for its use during the assessment.

Objective of the Assessment: Main objective of the assessment is to identify energy saving opportunities for selected heating systems in the plant, to provide hands-on training and demonstration of the data collection process, and analyze results to estimate potential savings for the identified opportunities by using PHAST program and other available calculating methods.

Focus of assessment: The assessment was focused on process heating systems that use natural gas as source of heat for process heating. The team visited the following gas fired equipment and collected data for some of this equipment to conduct energy savings opportunity analysis. Following table gives the list.

Fired Equipment	Description	Data collection and Analysis
# 15 melting furnace,	Reverbaratory melting furnace	YES
#5 holding furnace,	Molten aluminum holding furnace	YES
#1 chip melter and	Melting furnace with regenerative burners that uses preheated chips as charge material.	YES
#19 homogenizing furnace	Gas fired furnace used for homogenizing cast aluminum metal logs	YES

Approach for ESA: The assessment activities included (a) review of energy use by the plant, (b) plant tour, (c) brief introduction and demonstration of PHAST and instructions on its use, (d) collection of the required data for PHAST, and (e) analysis of energy saving opportunities for the systems mentioned above. The performance information was derived from historical data or control room data or actual measurements carried out by the team members. Several additional issues related to operation, maintenance and use of new technologies were discussed. The plant management was briefed on the assessment results on the third day of the assessment.

General observations. Alcoa Massena West plant is the oldest existing aluminum production plant in the USA. The plant includes a large number of gas fired heating equipment that was designed and installed during 1960s and have been modified or rebuilt several times since the original installation. The plant management has been active in exploring and implementing energy saving practices throughout the plant. The assessment team members provided help and cooperation in discussing and collecting performance data and demonstrated willingness to continue to use the methodology and tools demonstrated during this assessment. They are extremely interested in pursuing short and medium term energy saving opportunities. Since this is a large facility natural gas consumption is significant and a major component of production costs. The plant uses large amount of electricity however at this time electricity used in the areas where this assessment was carried out was not available.

Potential opportunities: Major energy saving opportunities identified during this assessment are discussed below. The following areas of actions are identified for energy savings in the furnaces surveyed during this assessment. A short description for specific applications is given in the following paragraphs.

- Control of excess air or oxygen in flue gases
- Reduction of air leakage through sealing the openings
- Furnace pressure control at proper location
- Reduce door opening time and eliminate or reduce other openings to avoid radiation heat loss.
- Recover waste heat by using short and long term heat recovery projects. Examples: combustion air preheating, charge preheating, space heating etc.

There are other areas of energy saving opportunities for other equipment that we did not visit. Energy saving opportunities for the equipment we visited and analyzed represent potential savings varying from \$57,000 to as high as \$1.6 million per year for the furnaces/equipment assessed during this visit. Generally near term (<2 year payback) opportunities identified during this assessment may save 1.5% to 3% and the medium term (< 4 years payback) opportunities may save >3% natural gas cost. The long term (> 5 years) opportunities related to process changes etc. can result in substantially more savings (not estimated at this time).

These savings are based on historical data provided by the plant or “spot-check” for selected furnaces operating at the condition when the assessment was carried out. Estimate of savings should be considered as sample of possible savings. The plant personnel attending the assessment have shown willingness to use PHAST program and methodology to calculate savings for other equipment over a longer operating period. They are very keen on further analyzing and applying the necessary measures that can be economically justified.

A brief description of the selected saving opportunities is given below.

Near Term Opportunities

1. Combustion control – Reduce O₂, CO and combustibles in exhaust gases by proper adjustment of burners and elimination of air leaks in the furnace. Presence of relatively large percentage of oxygen (approximately 6%) indicates that the furnace is getting more air than required for combustion of the fuel used. This air may be coming from the burners and/or air leaks into the furnace. The plant is tuning the burners to maintain appropriate air-fuel ratio going to the burners at one particular operating conditions however it is likely that the ratio is not precisely maintained at other firing rates, This can be corrected by using a mass flow ratio control system to tune the burners and to maintain proper air fuel ratio for all operating conditions for the melting furnaces. This would reduce use of excess air in the burners at low firing rate could save energy cost. However this does not guarantee reduction of oxygen in flue gases or excess air going through the stack. It is necessary to take additional action of reducing openings (gaps in the seals etc.) and use of pressure control system to maintain near zero pressure differentials at the areas where there are openings. All of these actions could result in reduction of oxygen and excess air in the flue gases. Calculations for energy cost savings show that when the flue gas O₂ is reduced from current level of 6% to 3%, it is possible to save approximately 25,440 million Btu in natural gas heat input with \$229,000 per year in natural gas cost. Similar savings could be possible for other melting – holding furnaces. Note that these savings are achieved when other change of energy savings (mentioned above) in the furnace operation or design are not used. If any other change is carried out (such as use of preheated air or preheated charge material) then the actual savings would be lower.
2. Reduce door opening time by 25% for #15 melting furnace. Furnace doors are opened to charge liquid metal or other type of charge material and for skimming or removal of dross from the melting furnace. A large amount of heat is lost by radiation from the furnace when the door is opened and hot furnace surfaces are exposed to the ambient conditions. The plant estimated that at this time such door openings are for about 4 hours per day. With proper scheduling and operator awareness it is possible to reduce this time to 3 hours per day. This step will reduce radiation loss and hence heat requirement for the furnace. Calculations for heat losses show that reduction in door opening time by 25% can reduce energy use by 6,333 million Btu/year or energy cost savings of \$57,000 per year. Note that this is based on flue gas temperature of 200 deg. F. and 6% O₂ in flue gases. The savings would be reduced somewhat when the burners are tuned properly to maintain lower O₂ in flue gases.
3. Maintain proper (slightly positive pressure) in the furnaces at the areas that cannot be sealed properly for chip melter # 1. During assessment of the chip melter #1, substantial openings were observed near and underneath the furnace door. This furnace uses regenerative burner so the furnace pressure at the openings changed as the burners came on and off. The pressure variation was from -0.07 inch w.c. to 0.0 inch w.c. during a typical burner firing cycle of 20 seconds. Potential energy savings were estimated based on average pressure of -0.005 inch w.c. and opening size of 5 sq. ft. (the door with gap of 3 inch average and linear dimension of approximately 20 ft). Based on this elimination of air leaks either due to proper pressure control or sealing the doors to eliminate air leaks, could result in energy savings of 2.75 million Btu/hr. For total opening time of 8000 hours/year the energy savings would be 22,000 MM Btu/year or \$198,570 per year.
4. Combustion air preheating to approx. 150 deg. F. using “affordable” methods for melting furnace #15. At this time flue gases from the furnace #15 are discharged without any heat recovery. Several methods of heat recovery were considered. One of the options is to install a simple radiation type recuperator for the stack to preheat combustion air. This type of arrangement does not offer large surface area hence the degree of combustion air preheat is small. It is possible to preheat combustion air to about 150 deg. F. This amount of preheat will allow continuing use of current burners and piping, valves etc. on the air side. This will eliminate major expenses

associated with burner and air piping replacement. For this melter the burners are operated in high-low fire mode. The plant personnel mentioned that the burners operate at “full” fire condition only for about 1/3rd of the total operating time or 2880 hours per year. Based on the high fire rate and these operating hours, use of 150 deg. F. combustion air (as opposed to 70 deg. F. average for the current operation) can save 7,333 million Btu/year or \$66,000 in natural cost year per year.

Medium Term Opportunities

5. Use of regenerative burners for #15 melting furnace. The plant uses regenerative burners to recover flue gas heat for the chip melters. This type of burners can recover more than 70% of the heat. Even though melter #15 is fired at full fire condition only for approximately 1/3rd the time, use of regenerative burners can still be a good option to reduce energy cost for this melter. Based on annual operating period of 2880 hours when the burners are at full fire, use of regenerative burners can result in energy saving of approximately 77,780 million Btu/year or energy cost savings of \$700,000 per year. These burners require substantial investment and frequent maintenance if the flue gases contain particles and other contaminants that would plug the bed or chemically react with the bed media used in the regenerators. Note that use of regenerative burners would reduce or eliminate the savings reported under recommendations no. 1, 2 and 4 above.
6. Charge preheating to about 500 deg. F. using furnace flue gases for #15 melting furnace. One option for recovering flue gas heat from a melting furnace is to use the flue gas heat to preheat charge material. This option can be used if the option of preheating combustion air is considered impractical or the heat recovery is relatively low (of the order of 50% or less) so that the flue gas temperature is still above 800 deg. F. to 1000 deg. F. Higher charge temperature reduces need for heat in the furnace and may allow higher production (melt) rates if required. In this case it is assumed that the charge material can be handled when it is heated to about 500 deg. F. Use of preheated charge can reduce energy use and save 38,890 million Btu/year or \$350,000 in natural gas cost. This is based on current production rate of 5,555 lbs./hour and 8,640 hours per year or annual production rate of 24,000 tons per year. Note that this option cannot be used if the furnace uses regenerative burners since flue gases from the regenerative burners are usually at less than 400 deg. F.

Long Term Opportunities*

7. Use of a “unitized” fluid heater on 8 furnaces to heat liquid that can be used for space heating. The plant has 8 furnaces that discharge flue gases with more than 50% of the total heat input for each furnace. This heat is currently wasted. At the same time, the plant uses a large amount of steam to heat the buildings during cold weather conditions that lasts for 6 to 7 months. The plant has a history of installing a centralized boiler to recover flue gas heat. This system required extensive and large diameter duct work that ran for hundreds of feet and required transport of high temperature flue gases from furnaces. During this assessment we discussed an alternate method of flue gas heat recovery to heat the buildings and eliminate use of steam. The system includes water or appropriate liquid heaters located at each furnace and a continuous loop of liquid pipes that would collect hot liquid from each of the heat exchangers and deliver “colder” liquid to the heat exchanger. The liquid piping is much smaller in size and it will eliminate need for high temperature large size ducts. This system has potential to reduce energy use in steam boilers and natural gas savings of 180,000 million Btu/year and cost savings of \$1,620,000 per year.

A list of opportunities, divided into three categories (Near term, medium time frame and long term) is given in Figure 2. This figure includes definition of near term etc.

Details of the savings estimate made by using PHAST program and the calculators were submitted to the plant personnel. They can be used for future estimates.

Management support and comments: The plant management is highly supportive of implementing the near and medium term opportunities with due considerations for the long-term opportunities. They are interested in learning more about energy saving opportunities for all energy user systems used in the plant and would send selected personnel for training, as these opportunities are made available in the near-by area.

Need for DOE to contact plant/company: DOE may contact Michael Caufield of Alcoa to monitor progress made towards implementation of the recommendations.

Report prepared by

Arvind Thekdi, E3M, Inc.
December 23, 2008

Figure 2: Summary List of Recommendations

Near Term*

1. Combustion control – Reduce O₂, CO and combustibles in exhaust gases by proper adjustment of burners and elimination of air leaks in the furnace.
2. Reduce door opening time by 25% for #15 melting furnace.
3. Maintain proper (slightly positive pressure) in the furnaces at the areas that cannot be sealed properly for chip melter # 1.
4. Combustion air preheating to approx. 150 deg. F. using “affordable” methods for melting furnace #15.

Medium Term*

5. Use of regenerative burners for #15 melting furnace
6. Charge preheating to about 500 deg. F. using furnace flue gases for #15 melting furnace. .

Long Term*

7. Use of a “unitized” fluid heater on 8 furnaces to heat liquid that can be used for space heating.

*** Notes:**

1. Definitions of the terms.
 - ❑ The near term opportunities include actions that could be taken as improvements in operating practices, maintenance of equipment or relatively low cost actions or equipment purchases.
 - ❑ The medium term opportunities would require purchase of additional equipment and/or changes in the system such as addition of air preheaters, other types of heat recovery capability or adding insulation for furnace walls. It would be necessary to carryout further engineering and return on investment analysis.
 - ❑ The long term opportunities would require extensive modifications to the equipment or the plant, testing of new technology and confirmation of performance of these technologies under the plant operating conditions with economic justification to meet the corporate investment criteria.